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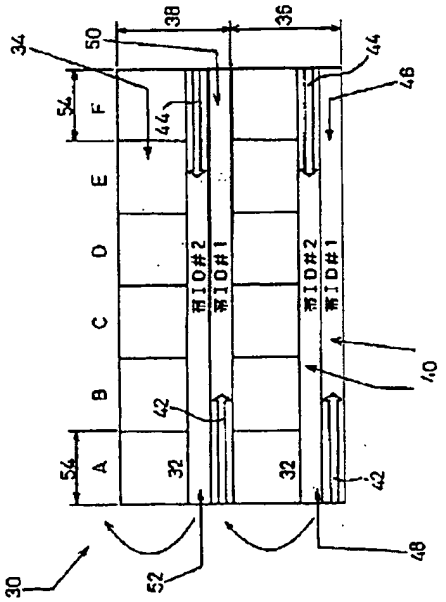
BENJI SENDAA

(54) TWO-DIMENSIONAL STRUCTURE INSPECTION METHOD AND DEFECT INSPECTION METHOD

(57) Abstract:

PROBLEM TO BE SOLVED: To achieve the maximum detection sensitivity and throughput and at the same time inspect an edge die in real time by acquiring the images of first and second bands in a first column, and at the same time by acquiring the image of the first band in a second column with essentially the same direction as the first band in the first column for performing adjacent comparison.

SOLUTION: A wafer 30 including a plurality of dies 32 includes at least two columns 34 including first and second columns 36 and 38. Along with first and second bands 42 and 44, a virtual band 40 is an image that is obtained in a stage over an entire wafer 30 or one scanning process of a camera. Also, the virtual band 40 is provided with a smaller width than the total width of the die 32, and at least two virtual bands 40 for covering the entire width of the die 32 are required. The camera first scans a first band 46 of the first column 36 as one portion of the virtual band 42 and then scans the second band 48 of the first column 36 as one portion of the second virtual band 44. Then, the first and second bands 50 and 52 are scanned as each one portion of the virtual bands 42 and 44 regarding the second column 38.



CLAIMS

[Claim(s)]

[Claim 1] The two-dimensional structure inspection method characterized by providing the following that it is the two-dimensional structure inspection method of inspecting existence of the defect of two-dimensional structure, and the aforementioned two-dimensional structure has the 1st line of a period, and the 2nd line of a period at least including the period of plurality [structure / two-dimensional / aforementioned], and at least one boundary period of each aforementioned line is an edge period (a) The step which acquires the picture of the 1st band in the line of the above 1st, and the picture of the 2nd band at least so that even bands may be obtained within the line of the above 1st (b) The step in the line of the above 2nd which corresponds to the 1st band of the above of the 1st line of the above, and has the same direction substantially with the 1st band of the above of the 1st line of the above and which acquires the picture of the 1st band at least (c) The step which compares a part of aforementioned picture corresponding to the aforementioned edge period of the 1st band of the above of the 1st line of the above to a part of aforementioned picture corresponding to the edge period of the 1st band of the above of the 2nd line of the above so that 1st contiguity comparison may be performed about the edge period of the 1st line of the above about the 1st band of the above at least

[Claim 2] the period of an addition of the 1st line of the above -- the special feature -- carrying out -- the aforementioned two-dimensional structure inspection method -- (d) -- so that 2nd contiguity comparison may be performed about the edge period of the 1st line of the above about the 1st band of the above As opposed to a part of aforementioned picture corresponding to the period of the aforementioned addition of the 1st band of the above of the 1st line of the above In order to judge whether a defect exists in the edge period of the 1st line of (e) above to be the step which compares a part of aforementioned picture corresponding to the aforementioned edge period of the 1st band of the above of the 1st line of the above The two-dimensional structure inspection method according to claim 1 further equipped with the step which investigates contiguity comparison of the above 1st, and contiguity comparison of the above 2nd.

[Claim 3] The two-dimensional structure inspection method according to claim 2 that the aforementioned two-dimensional structure is the semiconductor wafer with which two or more dies were arranged periodically, therefore each aforementioned die is a round term.

[Claim 4] The two-dimensional structure inspection method according to claim 2 that the aforementioned two-dimensional structure is the phot mask with which two or more dies were arranged periodically, therefore each aforementioned die is a round term.

[Claim 5] It is the defective inspection method which is characterized by providing the following and which carries out defective inspection of some wafers [at least] of a die. The aforementioned wafer has the 1st line of a die, and the 2nd line of a die at least. The defective inspection method that each of the 1st line of the above of a die and the 2nd line of the above of a die is an edge die [in / both the 1st line of the above of a die, and the 2nd line of the above of a die /, including the 1st die and 2nd die / in the 1st die of the above] at least (f) It is the step which acquires the picture of the 1st band of the 1st line of the above of a wafer die, and the width of face of the 1st band of the above is a step smaller than the width of face of the 1st line of the above. (g) The sense of the 1st band of the above is a step whose sense of the 2nd band of the above is a retrose as it is the step of the 1st line of the above of a wafer die which acquires the picture of the 2nd band at least and the picture of even bands is acquired about the 1st line of the above. (h) It is the step which acquires the picture of the 1st band of the 2nd line of the above of a wafer die, and the aforementioned sense of the 1st band of the above of the 1st line of the above and the sense of the 1st width of face of the above of the 2nd train of the above are the same step substantially. (i) So that 1st contiguity comparison may be performed about the aforementioned edge die of the 1st line of the above about the 1st band of the above As opposed to a part of aforementioned picture corresponding to the 2nd die of the 1st band of the above of the 1st line of the above The step which compares a part of aforementioned picture corresponding to the aforementioned edge die of the 1st band of the above of the 1st line of the above, (j) So that 2nd contiguity comparison may be performed about the

edge die may carry out defective inspection The step which compares the above of the picture corresponding to the aforementioned edge die of the 1st band of the above of the 1st line of the above part to a part of aforementioned picture corresponding to the aforementioned edge die of the 1st band of the above of the 2nd line of the above [Claim 6] (k) The defective inspection method according to claim 5 further equipped with the step which investigates contiguity comparison of the above 1st, and contiguity comparison of the above 2nd in order to investigate whether a defect exists in the edge die of the 1st line of the above.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the inspection method for detecting the irregularity (called a defect below) in two-dimensional periodic structures, such as a wafer die or a phot mask. this invention makes it possible to inspect such periodic structure one by one on real time, and includes that this inspection inspects the period (repeat pitch) in the edge of two-dimensional structure without loss of a throughput.
[0002]
[Description of the Prior Art] While a semiconductor wafer die, a memory cell, and periodic structure like a phot mask manufacture the inspection for detecting existence of the defect which appears in them, it is necessary to perform them, and as a result, a production cost is reduced. It is superfluously labor-intensive to conduct this inspection by the handicraft, and since many working hours are required, it is impossible to perform the whole of this inspection by the handicraft. Instead, inspection is automatically conducted by moving the body to the optical system for inspecting some bodies [at least] including this structure relatively. It is convenient to form the system as a camera of the limited width of face which acquires some objective sequential pictures until the whole request zone finishes being scanned in the process known as "a scan", in order to give explanation clear.
[0003] Each zone of the body scanned in 1 time of the distance of this camera is "a band (swath)." In the case of a wafer die, typically, the width of face of this band is smaller than the width of face of a die. In the case of a wafer, the band only containing the single period (single die) of a wafer is defined as "a die band (die swath)." The band which covers the same portion of each die about all the dies in a wafer is defined as "a virtual band (virtual swath)." A virtual band features the picture of some die bands (in general wholly [the die band / Suitably / in the wafer]) connected with the form of the continuous long die band picture taken from the in general same portion of each die in a wafer.
[0004] The three band type example is shown in drawing 1 which shows the method of background technology. A wafer 10 is characterized by two or more dies 12 currently composed by the form of a line 14. Each of a die 12 is shown with the die band 16 located in the in general same place about all the dies 12. 1 set of die bands 16 from each line 14 are bands 18. All the bands 18 form a virtual band as a whole.
[0005] The conventional detection process is based on analysis of the collating signal acquired from some periods (period). Detection of a defect is based on statistical approach and this means that the probability that a defect exists in the same place in each adjoining die is very low. Therefore, detection is based on tracing the position of irregularity by use of 3 die comparison method shown in drawing 2 .
[0006] Drawing 2 shows the band 20 characterized by five die bands 22 from five dies shown with the sign of "A", "B", "C", "D", and "E." The brightness difference about the picture of each nearest neighbors 22 of a die band is compared with a threshold, and the output of this comparison is the comparison signal 26. When this brightness difference exceeds a threshold, it is said that the comparison signal 26 is effective. Therefore, a proper threshold must be set up so that so robustly [it is so sensitive that the system is enough to detect the defect which is low contrast, and] that it is enough to disregard the noise which is high contrast. Therefore, the threshold should express the estimate of a strict pixel noise.
[0007] At drawing 2 , the comparison signal 26 is displayed with the sign of AB, BC, CD, and DE. Each of the comparison signal 26 is a picture which shows a position with the irregularity in which the effective deflection between the signals acquired about the nearest neighbors 22 of a die band exists. Various algorithms for calculating the proper threshold the difference signal from one certain die for filtering this signal indicates the potential fault in the die to be are proposed. An example of such an algorithm is indicated by U.S. Pat. No. 5,537,669.
[0008] The defective picture 28 is the result of being obtained by defective discernment processing performed using one pair of contiguity comparison signals 26. Defective discernment processing discriminates the defect of the specific die, when comparing a certain specific die with the adjoining die and

statistically in the same place on two or three wafer dies. Therefore, by performing defective discernment processing between the comparison signals acquired from the die which adjoins each other mutually, existence of a defect 25 is able to be detected (when a defect exists), and detection of random noise is reduced.

[0009] The technical term "random noise" is drawn in brightness comparison processing, and means a ****** noise. Such a comparison has the limited probability that brightness comparison will generate random noise 24 exceeding a threshold, when it generally has big distribution, therefore a defect does not exist. In one comparison, in a typical threshold, the probability of such an event is slight, and it is zero in general about such two events over the same pixel. therefore, defective discernment operation -- generating of such an event -- zero -- or the level near zero should be decreased

[0010] The fault of the die shown as "B" gives an important comparison signal between the die bands 22 shown as "B" and "C" between the die bands 22 shown as "A" and "B", and defective discernment operation is truth as the result in a defective position. I hear that a defect should produce the important comparison signal 26 and most above-mentioned noises are eliminated as a result of fault discernment operation about two adjoining die bands 22, and there is an advantage of this method. In addition, since such a process is performed repetitively [the step required for picture acquisition and processing is specified clearly, and], it is suitable for especially the real-time image processing system. This step is as follows. The picture of the die band A about a die "A", i.e., a "die band", is incorporated by the beginning, and it memorizes at the memory of a system. Next, the picture of the die band B about a die "B", i.e., a "die band", is incorporated and memorized. Each picture is incorporated as two or more frames, and these frames are the batches in a die band. Each incorporation frame of the die band B is adjusted with the correspondence frame of the die band A for comparison, and a comparison signal reliable as the result is acquired.

[0011]

[Problem(s) to be Solved by the Invention] Since all the pictures of the die band B are incorporated, the comparison picture called picture AB is produced. Next, the die band C is incorporated and the comparison picture BC is generated. The defective discernment operation performed between Picture AB and Picture BC makes it possible to detect the defect which exists in Die B. It is not effective in order for a regrettable edge die [like Dies A and E] whose method of this is to detect a defect especially. For example, the defect of Die A may be detected as a result of the defective discernment operation between AB and BC. Although such a defect produces an important comparison signal in AB, on the other hand, the corresponding point of BC signal does not contain such irregularity. Therefore, to existence of a high contrast noise, defective discernment operation to an edge die like Die A is not performed only once, but it is sensitive, and for the reason, misconception is imitated and ****** is brought about.

[0012] Therefore, inspection of an edge die has two troubles. In order that such an inspection may perform additional defective discernment operation to the 1st, the processing step of the addition which is not included in the usual processing path is needed to the remaining portion of a wafer, and a system throughput is reduced as the result. In addition, the result which many about defective detection mistook for the existence of this operation of random noise is produced.

[0013] Although such a trouble of the defective detection in an edge die is well-known in this work field and the solution of at present and some is well-known, such a well-known solution is inadequate. The 1st solution is that declare that all edge dies are unsuitable and all such edge dies are simply disregarded in an inspection process. Since it is inefficient-like [eliminating all edge dies] and is cost quantity, this solution is clearly disadvantageous. The 2nd solution is increasing a comparison threshold so that it may be required for an effective difference to be further still larger in the case of an edge die. Although this solution eliminates the great portion of random noise, it reduces detection sensitivity simultaneously. The 3rd solution is using an additional stage after processing processing and checking existence of the defect on an edge die, and an edge die is inspected in this additional stage by the 2nd comparison between an edge die and the die separated from this edge die by two dies. The fault of this method is that an additional time overhead is required for such operation.

[0014] Still more nearly another solution is comparing the signal of the picture acquired from two bands of a wafer die as shown in drawing 3 . In the case of this solution, at least two lines 14 of a wafer die are needed. Comparison is performed between the signals acquired from the picture of the 1st die 12 of each line 14 which gives two the "contiguity dies" for comparison effective in each edge die 12, and whose both are the edge dies 12. However, before the picture compared having the reverse sense mutually in the edge, therefore comparing, the sense of one picture of these pictures must be made into a retrose. The picture from two bands 16 which adjoin mutually is mutually photoed in the direction of [on the wafer 10 of a retrose] on the basis of a camera, as the result, artificial deflection is made for me to hear that it is generated in many cases by the comparison signal, and one of the faults of this method is in it. Such a noise source causes that detection sensitivity is reduced, in order to avoid the error about defective detection. Therefore, a suitable solution will be characterized by comparison of two or more signals mutually acquired in the same sense. Such a solution cannot be used for a regrettable thing.

[0015] Therefore, it can be said that it is useful for the method of

realizing the greatest detection sensitivity and the greatest throughput, and to have such a method.
[0016]
[Means for Solving the Problem] this invention is the method of comparing such periodic structure by acquiring a signal from the picture of the virtual band of the even number of periodic structure like a wafer die simultaneously. By this method, the signal about each wafer die is compared with the signal from other two dies at least. the inside o the line as the die concerned with these two same dies -- and being located in the both sides of the die concerned is desirable however -- the case of an edge die -- the inside of line (line which adjoins each other suitably) with at least one another contiguity die -- and being located in the opposite side of the band is desirable
[0017] By the method of this invention, before a picture is acquired from the equivalent band in the 2nd [of a die] line, a picture is incorporated and processed from the band (for example, two or more bands) of the even number in the 1st [of a die] line. A camera (therefore, picture acquired as a result) is correctly oriented, in order to acquire a quality signal from the equivalent band in the 2nd [of a die] line. Such a method makes it possible to compare the signal acquired from the band of the 1st line of a die and the 2nd line of a die containing an edge die proper.
[0018] Below, a technical term "a band" means each zone of the body scanned in 1 time of the distance of the camer from an objective edge to an edge. Below, a technical term "periodic structure" contains a wafer die, a memory cell, and a phot mask in un-limiting. A technical term "a wafer die" and a technical term "a semiconductor wafer die" mea mean the wafer divided into the form of the die for manufacture of a semiconductor chip so that each die may becom each chip like a memory chip or a microprocessor chip. The type of a chip made from each die is unrelated to the method of this invention.
[0019]
[Embodiments of the Invention] this invention relates to the method of comparing such periodic structure on real tim by acquiring a signal from the picture of the virtual band of the even number of periodic structure like a wafer die. The signal about each die band of a wafer die is compared with the signal from other two dies at least. suitable -- the inside of the line as the die concerned with these two same contiguity dies -- and it is located in the both sides of the die concerned However, in the case of an edge die, it is desirable that at least one contiguity die is located in another line (line which adjoins each other preferably).
[0020] According to the method of this invention, before an equivalent picture is acquired from the band of the same number in the 2nd [of a die] line so that it may be the sense as the band with which it corresponds in the 1st [of a die] line with the same band of the die in the 2nd [of a die] line, a picture is acquired from the band of the even number in the 1st [of a die] line. By adjusting a die picture to the same direction, it becomes possible to measure high sensitivity from the signal's acquired from the band of the 1st line of a die to the signal acquired from the band o the 2nd line of a die.
[0021] The method of this invention has some advantages compared with a well-known method in this work field. Unlike some well-known methods, the method of this invention enables inspection of an edge die in this work field that only eliminates an edge die to the 1st, and carries out the disposal of these edge dies to it first at the time of inspection processing. It is inefficient-like [futility / there is much futility and] to carry out the disposal of the edge die with a natural thing.
[0022] The method of this invention already makes [2nd] it possible to compare the signal acquired from the picture of the edge die made into the proper sense. Therefore, it is not said using the reverse stage and camera polarity which may produce the noise relevant to the signal-detection system that comparison between die bands is performed. The method of this invention supports [3rd] the a large number die comparison by three or more dies. Since a virtual band is scanned by the suitable example of the method by this invention, the same die band is scanned over the whole wafer. Therefore, each virtual band has many periods and becomes possible [analyzing a bigger group than a die's statistically in an advanced form by this for the determination of a threshold].
[0023] Although it is assumed that it is the die whose period is one and the picture is assumed to be what is obtained from a die wafer in the following example of this invention, this is a thing for explanation of this invention, and it does not have the intention of limiting this invention in a certain form. The principle of a method and operation by this invention for inspecting one which lacks at least one contiguity die along with the edge die or scanning axis of periodic structure of other periods will be more appropriately understood with reference to an accompanying drawing and explanation. in addition, these drawings are shown for instantiation -- **** -- please do not pass but limiting this invention should understand not having intention at all
[0024] Now, when a drawing is referred to, drawing 4 is the rough block diagram of two or more wafer dies currently inspected by the method of this invention. Drawing 4 shows some wafers 30 containing two or more dies 32. The die 32 is constituted by the form of two lines 34, and each line 34 contains six dies 32. Since each line 34 needs to contain at least one die 32, a die 32 and the above-mentioned number of a line 34 only being shown for explanation, and limiting this invention should understand not having intention at all. A wafer 30 must contain at least two lines 34

virtual bands 40 is shown to drawing 4 by the arrow. Each virtual band 40 is a picture acquired according to 1 time of the scanning distance of the stage covering the whole in general or camera of a wafer 30. In order for each virtual band 40 to have width of face smaller than full [of a die 32] and to cover the whole width of face of each die 32 as the result, such at least two virtual bands 40 are needed. The sense of the 1st virtual band 42 is contrary to the sense of the 2nd virtual band 44 as shown by the direction of an arrow. As a part of 1st virtual band 42, a camera (not shown) scans the 1st band 46 of the 1st line 36, and scans the 2nd band 48 of the 1st line 36 as a part of 2nd virtual band 44 to the degree. Therefore, in the case of the 1st line 36, both the 1st band 46 and the 2nd band 48 are scanned.

[0026] Next, the 1st band 50 and 2nd band 52 are scanned about the 2nd line 38 as a part of 1st virtual band 42 and each 2nd virtual band 44. Therefore, the sense of the picture of the 1st band 46 about the 1st line 36 and the sense of the picture of the 1st band 50 about the 2nd line 38 are substantially the same. Similarly, the sense of the picture of the 2nd band 48 about the 1st line 36 and the sense of the picture of the 2nd band 52 about the 2nd line 38 are substantially the same.

[0027] The edge die 54 (train shown as A ["A"] and "F") of both the 1st line 36 and the 2nd line 38 has only one contiguity die in the same line. Drawing 5 is drawing showing the flow chart of the method by this invention for conducting defective inspection to the die wafer which has the 1st line of a die, and the 2nd line of a die at least. Both the 1st line of a die and the 2nd line of a die have two edge dies at each. Each step of the above-mentioned method is as follows.

[0028] At Step 1, a camera acquires the picture of the 1st band of the 1st line of a wafer die. The width of face of this 1st band is smaller than the width of face of a die, therefore in order to cover full [of a die], at least two bands are needed. At Step 2, after the process of the scan of the band and inspection of the existence of a defect finishes, a system memorizes both the picture expressed as "F" of the last die (die in 1st line sequence F) of the band, and the comparison picture expressed as "EF."

[0029] At Step 3, a camera acquires the picture of the 2nd band of the 1st line of a wafer die. The sense of the 1st band is contrary to the sense of the 2nd band. At Step 4, a system memorizes both the picture expressed as "A" of the last die (die of the 1st line within the train shown as "A") of the band, and the comparison picture expressed as a "bus available" at the time of process killing of a scan of the band.

[0030] At Step 5, a camera acquires the picture of the 1st band of the 2nd line of a wafer die. The sense of the picture about the 1st band of the 2nd line is substantially the same as the sense of the picture about the 1st band of the 1st line. At Step 6, a band is inspected about existence of a defect as a continuation of the 1st band, and the 1st band of the 1st line and the 1st band of the 2nd line are combined with the form of the same virtual band as the result. It is desirable that defective discernment operation is performed using a comparison picture "FA" (comparison between Die F and Die A) and the comparison picture "EF" memorized for continuation of inspection routine so that the defect of the edge die "F" of the 1st line may be detected. At the time of band scanning process killing, at Step 7, a system repeats the process which memorizes the picture of the last die so that the picture of the last die may be usable because of processing of a consecutive line.

[0031] At Step 8, a camera acquires the picture of the 2nd band of the 2nd line of a wafer die. The sense of the 2nd band of the 2nd line is substantially the same as the sense of the picture about the 2nd band of the 1st line. At Step 9, a band is inspected about existence of a defect as continuation of the 1st band, and the 1st band of the 1st line and the 1st band of the 2nd line are combined with the form of the same virtual band as the result. It is desirable that defective discernment operation is performed using a comparison picture "AF" (comparison between A and F) and the comparison picture "bus available" memorized for continuation of inspection processing in order to detect the defect of the edge die "A" of the 2nd line. At the time of the end of inspection of the 2nd band, at Step 10, a system performs again the step of storage of the picture of the above-mentioned last die so that the picture of the last die may be usable because of processing of a consecutive line.

[0032] When even virtual bands finish being inspected, in Step 11, it is desirable that a system inspects the die located on the boundary of the above-mentioned virtual band about a defect. Finally, each virtual band has two dies (boundary) which are not inspected before. However, the remainder of the edge die which remains in a virtual band is completely inspected under the situation of real time.

[0033] Especially the above-mentioned explanation explained the method of this invention about the wafer die. Still more generally, it is possible by comparing two or more periods of the periodic structure with one period to express that it is the method of inspecting the random defect in periodic structure so that each period of periodic structure may be compared with the two adjoining periods for the method of this invention. About the period of the above-mentioned structure where it is located in the edge of the above-mentioned structure, at least one side of the two contiguity periods does not adjoin directly to an edge period so that this edge period may have only one contiguity die in the same line. The method of this invention corresponds to such an edge period by scanning the band of the even number of a retrose to the line of each period, before obtaining the same band about the line of the following period. Therefore, all the bands of each line equivalent in sequential have the same direction

adjoining period", has the picture and the same direction of the edge period itself about the 1st band. Therefore, in order to perform contiguity comparison, the picture of the 1st band of a non-adjoining period is able to be directly compared to the picture of the 1st band of an edge period. As mentioned above, the example of the periodic structure where the method of this invention is suitable contains a semiconductor wafer and a phot mask in un-limiting. In the case of a wafer, each die is a period, and when it is a phot mask, each die in the phot mask is a period.

[0035] It will be understood having the intention of the above-mentioned explanation being only mere instantiation o the method of this invention and that other various operation aspects can be realized in the thought of this invention and the range.

[Translation done.]

* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing (the 1) showing the feature of the defective inspection of the conventional technology to a wafer die.
[Drawing 2] It is drawing (the 2) showing the feature of the defective inspection of the conventional technology to a wafer die.
[Drawing 3] It is drawing (the 3) showing the feature of the defective inspection of the conventional technology to a wafer die.
[Drawing 4] It is the rough block diagram of an example of two or more wafer dies inspected by the method of this invention.
[Drawing 5] It is drawing showing the flow chart of the method of this invention.
[Description of Notations]
30 -- Wafer
32 -- Die
34 -- Line
36 -- The 1st line
38 -- The 2nd line
40 -- Virtual band
42 -- 1st virtual band
44 -- 2nd virtual band
46 -- The 1st band of the 1st line
48 -- The 2nd band of the 1st line
50 -- The 1st band of the 2nd line
52 -- The 2nd band of the 2nd line

[Translation done.]

* NOTICES *

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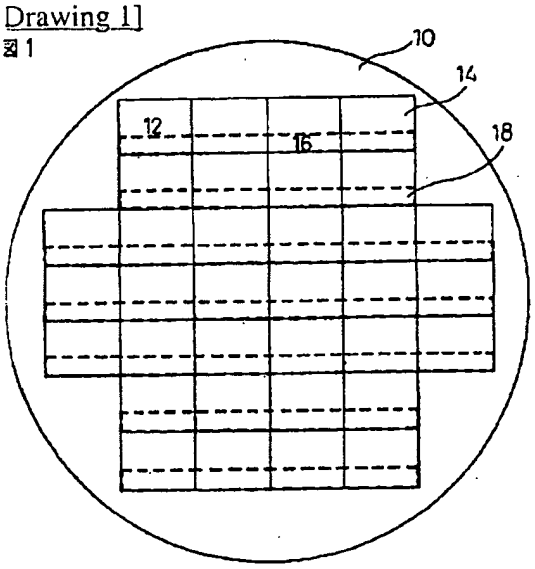
DRAWINGS

Drawing 1]

図1



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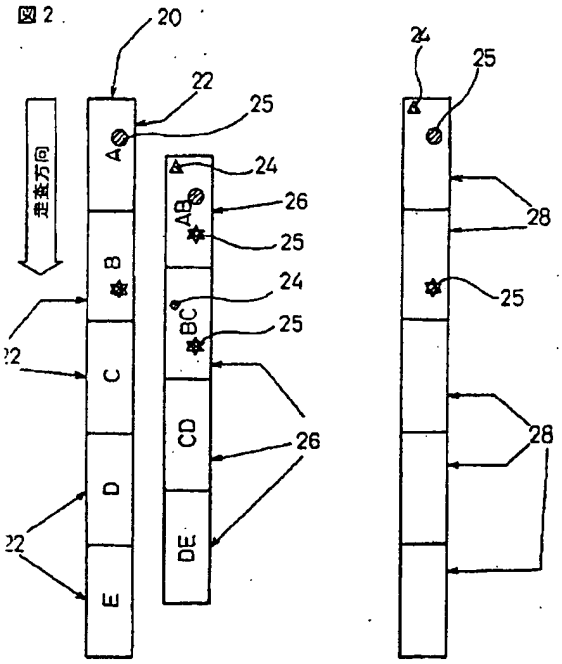
この長方形は「ダイ帯」を表す。

Drawing 2]

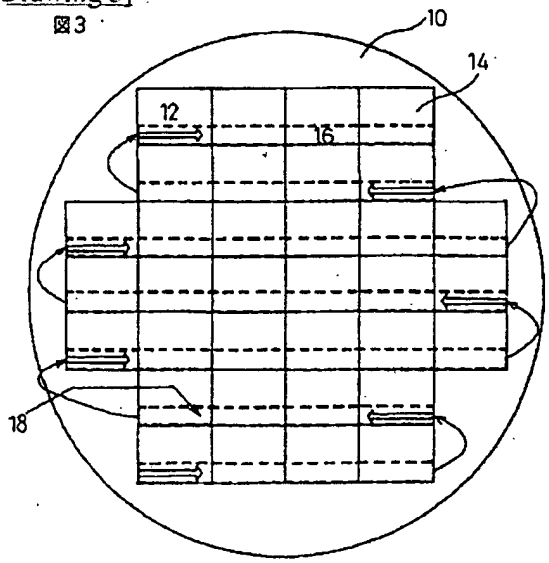
図2



△ ランダムノイズ
⊘ 真の欠陥
✽ 真の欠陥
● ランダムノイズ

Drawing 3]

図3



この長方形は1つのダイを表す。

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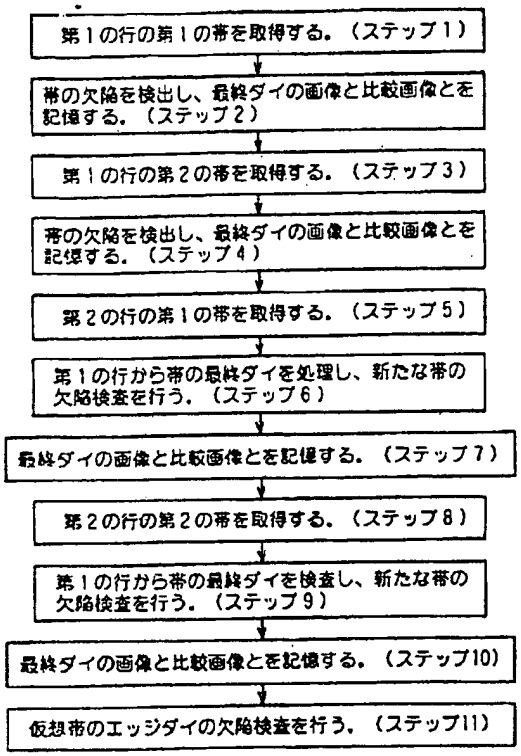
Drawing 5]

図5



[Drawing 4]

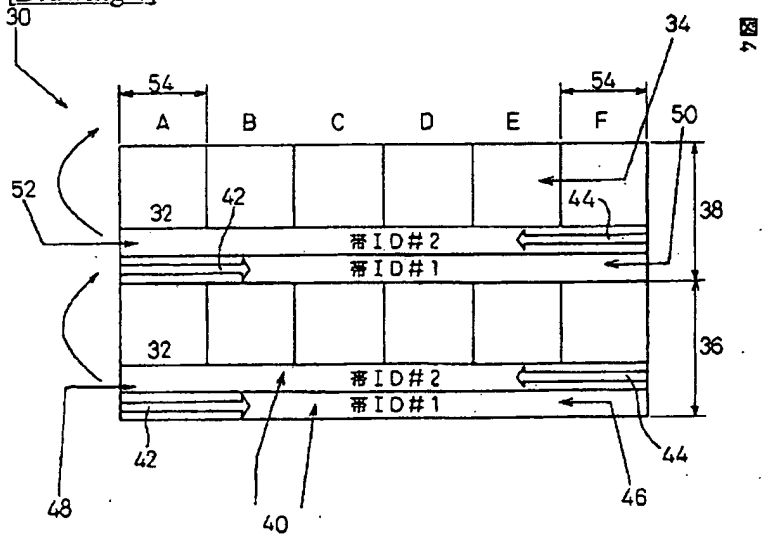


図4

[Translation done.]